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EXPERIMENTAL COURSES IN SECONDARY SCHOOL MATHEMATICS

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The National Committee on Mathematical Requirements, working under the auspices of the Mathematical Association of America, and numerous cooperating organizations, has prepared various reports dealing with the reorganization problems of secondary school mathematics. There is a growing sentiment against accepting materials of instruction or even outlines of courses that express merely an individual's opinion, especially if that opinion is not based upon class-room experience. But it is equally important to realize that a curriculum constructed in committee sessions, differs only in degree, not in kind. Fortunately, a milestone on the road of progress in education has been reached, which indicates that committee work that would eventuate, must be prefaced and supplemented by carefully made inventories of the experience that bears upon the problems studied. In consequence, a number of sub-committees have made studies of some of the details involved in the fundamental recommendations of the National Committee. One of these investigations deals with experimental courses in mathematics.

PURPOSE OF THE STUDY

The purpose of the study is to make generally available the experience of teachers conducting experimental courses in mathematics. Teachers will desire to know what is done by other teachers who are given greater freedom in choice of materials and methods, than is feasible in the typical public school. The value of this report is enhanced by the fact that the teachers in these schools, considered as a group, have wide experience, sound scholarship in mathematics, and unusual training in professional courses.

MATERIAL INCLUDED IN THE REPORT

The material includes a description of one or more courses in each of fifteen schools. Not all schools designated as experimental schools feel that they have made a contribution to the teaching of mathematics. The search for new materials by the National Committee on Mathematical Requirements has been wide spread. It is reasonably certain that no work considered unique by the persons doing the work has been omitted.

FORM OF THE REPORT

The whole report consisting of about 110 pages will be published sometime during the present year as a part of the final report of the National Committee on Mathematical Requirements. The report is presented in three parts—each for a special type of reader. The first part aims to meet the needs of the reader who is interested only in a general way, but who desires to survey the important implications of these innovations. These are presented in brief statements for the reader who does not desire to examine the evidence given in later parts of the report. The second part is for the type of reader who may wish to consider illustrations without going into the full details which constitute the basis for the statements in Part I. Part III is for the reader who has the time for and a genuine interest in considering more carefully some of the problems involved in improving the teaching of mathematics in secondary schools. This constitutes the source material of the report.

The material that follows is drawn from Part II of the report. It aims to amplify and to furnish illustrations of the important conclusions of the report.

1. *Only a Few Experimental Schools Have Made a Systematic Attack on the Mathematics Problem.* At the beginning of this study, a list of 175 schools which were giving courses more or less experimental in nature was prepared. It was desired at the outset to include every institution in which the teacher (or teachers) of mathematics felt that the experiment had progressed sufficiently for other teachers to profit by a detailed account. On this basis the list of experimental schools to be included was reduced to a brief one.

An experimental school must of necessity confine its constructive efforts to relatively few problems. Moreover, such schools are sometimes more concerned with becoming exponents of some philosophy of education or some educational ideal than in attacking a definite problem in a specific field. At any rate, there were very few experimental schools in which the teachers thought that they were teaching mathematics by other than conventional methods. Furthermore, it became clear that the report could not be complete without describing courses that are being taught in schools not generally considered experimental, as for example, Stuyvesant High School (New York City), East High School (Rochester, N. Y.), and the Cass Technical High School (Detroit, Mich.). The National Committee through its numerous cooperating organizations has solicited accounts of experiments in all sections of the country. The report includes a description of experimental courses in fifteen different schools.

II. *Experimental Work in Mathematics Not Scientific.* The word ''experimental'' is ordinarily used in a vague sense to indicate the use of materials or methods differing from those in current practice. But there is seldom an attempt to define the problem with precision or to measure the results; and rarely does anyone know when the experiment ends.

This leads one to say parenthetically that, viewed from an historical perspective, much of our accepted practice in high school mathematics has in this sense been experimental. The teaching of algebra alone in the ninth grade, and the teaching of demonstrative geometry in the tenth grade without propaedeutic training and the like, have at best been experiments in this sense, and perhaps very doubtful ones. In scientific education the word ''experimental'' has come to mean the study of a precisely defined problem under controlled conditions, and implies measurement of results. To have confined this report to such a definition would have excluded much material here presented which is nevertheless of great value. It represents at least the cumulative experience of critical, competent teachers. Accordingly, the reader will need to keep in mind that we are concerned in this report not so much with scientific experimentation as with purposeful innovations.

III. *Increased Emphasis Upon Experimentation.* We have reason to believe that the school world is putting a new emphasis upon investigation and controlled experimentation. It seems no longer sufficient to advocate an innovation on the basis of educational theory alone. Many school officials believe it highly desirable for a city or a school to incorporate experimentation as an important part of their program of education. The study of a problem by a group of teachers in a school system offers a means for stimulating discussion and genuine professional growth. S. A. Courtis includes controlled experimentation as one of the important duties of a supervisor. Such cities as Berkeley, Denver, Tulsa, Chicago, Rochester, Detroit, and many others, are engaged in setting up specific problems in mathematics and making it possible for groups of teachers to give them attention. To secure widespread cooperation in an experimental study that is clearly defined is no longer difficult. This increased interest in experimental work in mathematics is one of great significance and promise.

IV. *Teachers of Experimental Courses Well Trained.* The teachers of the schools described in this section have as a group an amount of professional training greatly exceeding that of mathematics teachers generally. Not only are they well prepared in mathematics, but also in general courses in education, educational psychology, measurements and special methods. The reasons are quite obvious. Some of these schools are in proximity to or directly connected with universities, thus affording opportunities for graduate study; in other schools the opportunity to do a constructive piece of work is the attractive feature; and in a few cases the salary is sufficient to command a choice of teachers.

The training of the teachers of the Cass Technical High School (Detroit) may serve as an illustration. In the year 1919-1920, the Cass Technical High School had thirteen full-time mathematics teachers. These teachers averaged 31½ semester hours preparation in college mathematics, and 13.8 semester hours in education courses. Roughly, this means that more than one-fourth of a four-year college course was devoted to mathematics, and a little more than one-ninth of a college course was spent in education courses. In addition, five teachers had completed courses in mechanical drawing during vacant hours in regular day school classes, seven had taken machine shop courses to gain knowledge of machine operations and vocabulary, one had sufficient training in the industries so that he was considered one of the best machine shop instructors in the evening classes, and eight had been given temporary approval as teachers of trade improvement courses under the Smith-Hughes law.

Not only are these teachers well trained in mathematics, but they are especially trained for a special task. It is a well known fact that cooperation schools connected with large industries have great difficulty in securing teachers who are sufficiently well trained in education to do satisfactory teaching, and that in attempting to meet occupational needs the public schools find it difficult to obtain teachers who possess the necessary practical experience in the industries to use real problem material. It is safe to predict that the notion that a department head in an industry is a "boss" will be supplanted presently by the idea that he is first of all a teacher. And it is equally clear that the training for a teacher of mathematics in a technical school needs to give increasing emphasis to trade vocabulary, processes, and the real problem material. The Cass Technical High School suggests a solution to the problem, applicable alike to industry and the public school.

The averages given for the Cass Technical High School teachers are probably somewhere near the median for the group as a whole and serve to make clear the fact that this report is concerned with the work of teachers with very unusual training. It is important to keep this fact in mind in considering the principles concerning which there is substantial agreement in this group. The courses are unique not because they are taught by inadequately trained teachers recently released from college and restless for something new, but on the contrary, because they embody the mature judgment of experienced, well-trained teachers. These teachers constitute a group in which we may reasonably expect practice to approximate theory. This should be kept in mind in reading the issues stated in articles eight to fifteen inclusive of this part on which there is substantial agreement, and which are sufficiently far reaching to reshape completely the teaching of mathematics in American secondary schools.

V. *The Emphasis on Grades Seven, Eight and Nine.* Most of the efforts to reorganize mathematics are being directed at grades seven, eight and nine. The coming of the junior high school is only partly responsible for the especial attention that is now being fixed upon these grades. At the beginning of the seventh grade, the pupils may be expected to possess the fundamental skills in arithmetic. Hence, this is the time for new materials and an extension of number and space relations. This may explain why there appears to be greater variety in seventh grade courses throughout the country than in the fifth and sixth grade courses. The statistics of elimination and the experience with general intelligence tests show that we are rapidly becoming a ninth grade nation. Whatever the causes may be, the schools are beginning to hold the children through the ninth grade. The ratio of pupils entering the ninth grade has shifted in a decade from about one out of eleven to about one out of three. This fact may partially explain the unusual effort to recast ninth grade mathematics.

Grades seven, eight and nine are now available for inculcating common ideas, ideals, attitudes and habits. Hence the numerous efforts to build basic courses in these grades. All the schools in this report which include seventh grade classes teach courses that differ widely from conventional courses. On the other hand, these schools teach many senior high school courses that are frankly conventional. The early reports of the National Committee were particularly devoted to grades seven, eight and nine, and undoubtedly the discussion of these reports gives additional emphasis to these grades. It is, perhaps, logical to await the day for improving the later grades until the work of the earlier grades on which these rest shall have become more satisfactory.

It should not be inferred, however, that the senior high school field is wholly neglected. Presumably, the Ethical Culture* School's plane geometry course can be considered a senior high school project. Miss Blair's advanced course at the Horace Mann School for Girls is a marked innovation. Mr. Reeve at Minnesota and Mr. Breslich at Chicago have each developed courses covering the senior high school. Miss Sanford of The Lincoln School teaches a course of college grade* to eleventh grade pupils, who have had but three hours of mathematics per week during the junior high school years. Both Mr. Schlauch's work (High School of Commerce) and the material of the Cass Technical High School touch the senior high school. It is of particular interest to note the efforts to teach the introductory notions of the calculus as is being done in at least three of the schools described, namely, The University High School (Chicago, Ill.), The Horace Mann School for Girls (New York), and The Lincoln School (New York).

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* The details of the courses referred to in this paragraph may be found in Part III of the complete report.

VI. *No General Agreement Concerning the Details of the New Program.* The strongest evidence that much detailed and exacting work remains to be done in organizing a sound curriculum in mathematics is the fact that there is no general agreement concerning the details of the reorganized courses to be found in the practice of these teachers. In the content and in the grade placement of the materials in various junior high school books, we have clear evidence of distinctly different hypotheses for the organization of the curriculum of grades seven, eight and nine. Some schools, for example, believe that the seventh grade should be given entirely to arithmetic. One school gives about one-half of the year to arithmetic and the remainder to intuitive geometry. Several are working out courses in general mathematics for all three grades of the junior high school. The Ethical Culture School gives most of the ninth school year to geometry. There are almost as many kinds of courses as there are schools.

Disagreement concerning grade placement is to be expected, for very little careful work has been done on this problem. Nor have we attempted to measure to what extent the alternative schemes are effective in forming desirable habits, giving useful information and increasing mathematical power, the reason being that we do not now possess adequate tests. It is important to recognize that the issues involved in improving mathematics cannot be wholly met by a committee report or by wide spread discussion. As Professor Young has stated: "The work for which the National Committee was organized truly begins when the recommendations of the report are being translated into practice by the detailed and exacting efforts of the classroom teacher."

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* In this course Young and Morgan's Elementary Mathematical Analysis is used. In the tenth grade the pupils study a conventional plane geometry text.

VII. *Agreement Concerning Fundamental Issues.* It would be erroneous, however, to infer that all is chaos in the reorganization movement in mathematics. There is agreement concerning issues that are sufficiently far reaching to reconstruct completely our high school mathematics. This important evidence is to be found in the fact that the articles VIII to XV inclusive of Part I were submitted to each one of the schools concerned with the request that the teachers indicate their acceptance, modifications or rejection of these articles. All but one of the schools responded. (It was seemingly not possible to reach Professor Meriam.) With one exception, to be stated presently, there was unanimous endorsement and acceptance of principles. Mr. Betz, speaking for the Rochester teachers, takes exception to articles XI and XIII, not because of any objection in spirit but because he believes that courses are already being modified along these lines. The far-reaching effect of some of these principles will be noted in the sections that follow in this part.

Another striking illustration of agreement concerning important issues is found in an experience of the National Committee. It will be remembered that the Committee published in Secondary School Circular No. 6, page 10, five suggestions for the arrangement of material for grades seven, eight and nine. Each one of these plans provides that at some time or other during grades seven, eight and nine, the pupils shall be taught applications of arithmetic, algebra, geometry and trigonometry. But a more startling fact is that in no one of these plans is it proposed that the whole year be given to any one of these subjects (arithmetic, algebra, or geometry). According to the plans proposed, there are but two alternatives: (1) the teaching of general mathematics throughout these years, or (2) the breaking up of each year into various units, algebra, intuitive geometry, trigonometry, and the like. Is it not remarkable that, after a wide spread discussion of junior high school courses involving nearly one hundred cooperating organizations and in spite of the fact that prevailing current practice devotes all of the seventh and eighth years to arithmetic and all of the ninth year to algebra, there should not be enough sentiment in the country to support at least one plan for the junior high school that would continue conventional practice?

VIII. *The Norms of Performance in Arithmetic Are Exceedingly Low.* Teachers of mathematics have in recent years had an opportunity to study the findings of numerous school surveys. One outstanding conclusion to be drawn is that the results obtained in the arithmetic of grades seven and eight are very unsatisfactory. We assume that in the first six grades the child shall attain a reasonable degree of accuracy and speed in the fundamental operations with integers and fractions. The result of tests show that this assumption is not even realized in the seventh and eighth grades. We have sufficient evidence to make us sympathetic with the complaints of the industrial and commercial world resulting from its contact with pupils who have achieved only 50% to 80% accuracy. This failure is probably not due to an insufficient amount of drill; it seems to be due, rather, to the fact that the drill is not directed at specific disabilities. The results of available tests do not in general enable us to analyze the pupils' dificulties. For example, one may give the Courtis Test in subtraction and learn that a pupil or a class is weak in subtraction. But the tests do not tell us what steps in the learning are in need of remedial treatment.

The foregoing conditions seem (without evidence based on standard tests) to exist with reference to percentage relations. This topic is generally considered important and it receives emphasis in text books. But the degree of mastery of percentage relations seems low even among college students. The experience of the teachers in these schools suggests that a satisfactory skill in computation cannot be assumed as initial equipment even among ninth grade pupils, and that adequate drill must be provided from time to time. In short, computation must be "kept going."

IX. *Delay of Social-Economic Arithmetic.* Although there is an increasing emphasis upon material that can be defended on a basis of social usage, it does not follow that a problem which involves principles that are widely used in every day affairs is either a real or desirable problem for children. Much emphasis is ordinarily placed on mortgages, stocks, promissory notes, cost of plastering, papering, and the like. These may at times be of interest to parents and to teachers, but it does not follow that these problems are vital to all the pupils or to any considerable portion of pupils in a class of twelve to fourteen-year-old boys and girls. There is a marked decrease in the amount of textual space devoted to these social-economic materials to be found in all eight of the junior high school seventh grade books that have as yet appeared. It is generally believed by teachers of these experimental courses (with the possible exception of the Trenton group) that this type of material calls for more maturity than is ordinarily possessed by seventh grade pupils. This does not mean that time should not be devoted to the arithmetic of the home and to a growing familiarity with common business forms, checks, personal accounts, and the like. But it is held that the applications of arithmetic to business may well be decreased in the early years and continued later in grades eight and nine so as to capitalize the increasing maturity, social experience and mathematical power. If we are getting to be a "ninth grade nation," the proposed suggestion is not only desirable but feasible. The delay of this material to later grades is advocated because of the demand of modern secondary education that social needs be more adequately met. These materials should be taught at a time when they are of the greatest profit to the pupils—keeping in mind that they must be taught before the pupils leave school.

X. *The Appeal of Mathematics.* There is a desire on the part of the teachers of these experimental courses to construct courses in mathematics that shall make a direct appeal to the pupil as being worth while here and now. If the new courses in mathematics are to respond to the modern demands in education, they must "reveal higher activities and make them both desired and to an extent possible." This suggests that there is to be less pyramiding (the practice of including elements to be used in problems occurring in later courses), and a more direct attack on the chief objective: an increased understanding and appreciation of mathematics. It is claimed that there are schools in this country giving rigorous courses in mathematics where the question "Why study mathematics?" or

"Why study this topic" is no longer asked in the spirit of dissatisfaction. Much thought is being given in these experimental courses as to how this number may be increased.

XI. *Formalism of Ninth Grade Algebra.* Extreme emphasis upon the manipulation of symbolism which does not have meaning and significance to the pupil, together with poorly selected content and material of little value even in later courses of mathematics, constitute the two pronounced indictments of the standard algebra of the ninth grade. This indictment has been often expressed, even by conservative mathematicians.

The standard ninth grade course in elementary algebra is in theory and symbolism substantially what it was in the seventeenth century. Fully 70% has been shown to be mere manipulation of symbols and drill on non-essentials set up fifty years ago. Ninth grade algebra has remained static, while the quantitative needs of high school children have changed. To be sure, we no longer teach as many as seventeen cases of factoring. But the Brinton study* makes it reasonably certain that ordinarily schools spend from four to six weeks on special products and factoring, three weeks on simplifying fractions, and something like eighteen more weeks of the school year on material equally useless. Experienced teachers and psychologists alike agree that pupils can learn to do this manipulation without associating it with meaning. Much of the manipulation of symbols in the ninth grade leads nowhere, not even in later mathematics. Professor Crathorne, who has had the opportunity each year to inventory the mathematical equipment of hundreds of Illinois freshmen, asserts that many of these students can factor with more facility than their instructors, and yet have but little understanding or appreciation of the simplest mathematical principles. It is significant that every one of the schools herein represented is concerned with the problem of simplifying the algebra of the ninth grade. Indeed the Las Vegas School went as far as to eliminate for a time all mathematics from the ninth school year in order to avoid objections to ninth grade algebra.

XII. *The Exclusiveness of Ninth Grade Algebra.* Not only are the teachers of these experimental courses concerned with the formalism of ninth grade algebra but they are determined to break up its exclusiveness. We have noted that the teachers of the Las Vegas School began their experiment by teaching no mathematics at all in the ninth grade. They chose to do this rather than to teach useless material. But they have come to believe that it is more important to strive to develop the right kind of course for the ninth grade. The exclusiveness of algebra has delayed to later courses the teaching material that is simple, worth while and significant to children. The most patent illustration of delayed material is found in numerical trigonometry. In the high schools of our large cities, most teachers have sufficient preparation to teach trigonometry, or at any rate someone in the department has. But even the simplest notions in this subject are seldom referred to until we reach the eleventh and more frequently the twelfth school year. This, in spite of the fact that the introductory notions of trigonometry, covering possibly three or four weeks' work, are exceedingly simple and are often the means of awakening a genuine and abiding interest in mathematics. While the case of trigonometry is more familiar to teachers of mathematics, other topics are perhaps even more important and more extensive. The graph is seldom introduced early or, if included, is not consistently taught as a vivid method for solving problems. The arithmetic involved in the elementary notions of statistics, the simple principles of mechanics, practical devices such as logarithms, the slide rule, and the like are equally neglected. So seldom are these topics taught that most high school graduates are denied the opportunity to obtain even elementary notions of these important tools. It is not necessary to argue the early introduction of these topics on the basis of practical usefulness. It is sufficient to point out that these constitute most effective ways of presenting quantitative data and relationships to children.

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* See Lee Brinton's question blank study, Relative Importance of the Topics of Algebra reported in Supplementary Educational Monographs, Vol. II, No 1. (The University of Chicago Press.)

Presumably the aims of reorganizing the mathematics of the ninth school year are identical with those for grades seven and eight. These aims seem to be well formulated in a report by the Chicago Principals Association published in full in the September number of the *Chicago Schools Journal.* According to this report the aims of teaching mathematics in these early years are: (1) "to apply computational arithmetic to the most useful phases of business practice and social applications, (2) to study space forms and relationships arising in linear, surface, volume, and angular measurements, (3) to study and to represent quantitative data and relationships by means of simple graphs, (4) to express quantitative relationships in the language of the formula and the equation and to evaluate and solve the same, (5) to study positive literal numbers and the necessary forms and operations to evaluate simple formulas and to solve simple equations, and (6) to practice at times on the fundamentals of computation until a norm of proficiency is acquired.''

In the discussion of Section VII it has already been pointed out that the five plans proposed on page 10 of Secondary School Circular No. 6 nowhere provide for a year to be devoted exclusively to algebra. The suggestion is that American Secondary Schools have experimented with the exclusiveness of algebra in the ninth year and have pronounced it a failure.

XIII. *The Special Difficulties of Demonstrative Geometry.* Teachers of mathematics have not surrendered the contention that plane geometry offers possibilities for practice in rigorous thinking. It is still believed that this field is rich in possibilities for giving a method of attack in problem solving and for analysis and, especially, for inculcating ideals as to precision and logical thought processes. It is also quite clear that the time and money spent on plane geometry cannot be justified on the basis of social utility. It must be defended for its contribution to a systematic technique of thinking or it must be omitted. In so far as conclusions are valid from questionnaire studies, it must be admitted that men and women of affairs are still guided by the conviction that plane geometry offers much in addition to information.

One may accept this argument presented by both groups as correct and yet insist that plane geometry as taught is an intolerable failure, because it falls far short of its possibilities. In his presidential address Professor Moore* pointed out the unwisdom of forcing children prematurely into this type of thinking. To be sure, a certain number in a geometry class who are chronologically quite young may succeed in doing plane geometry well. But this only furnishes additional evidence for Professor Moore's contention, for these children invariably have, as far as known, high intelligence quotients, and are therefore of high mental age.

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* Science, March 13, 1903.

Recognition of the special difficulties of plane geometry is clearly shown in the material of Part III of this report. To be sure, there is a very wide difference of opinion as to how the problem is to be solved. The Ethical Culture School, which perhaps has devoted most attention to plane geometry, offers one solution. The University of Chicago High School offers one that differs markedly. But the various plans are characterized by this important agreement that pupils shall no longer be permitted, much less required, to take a plane geometry course in the tenth or later grades wholly unprepared. If geometry is to be required, we can at least give pupils with fair (or greater) ability a chance not only to pass the course, but also to get a considerable amount of satisfaction from it. In many of these schools, plane geometry appears to be the most popular course, even with some pupils whose intelligence quotients are as low as "95-105." In every case, the pupils have been given the vocabulary, the symbolism and a preliminary organization (achieved through intuition and experiment) in the years that precede the plane geometry course. In some of the schools this preparatory geometry is given as a separate unit. For example, the Horace Mann School for Girls offers a plane geometry unit in the last half of the seventh school year. In The Lincoln School this geometry takes the form of a study of space forms and relationships arising in linear, surface, volume and angular measurements, and in the representation of quantitative data and relationships by means of simple graphs. In the measurement work of this school, it forms a basis for building up the concept of an algebraic number. It leads at once to the formula and the equation, to the evaluation of algebraic numbers, and to the substitution of special values in the formula. In this school the geometry is continued throughout the three years that precede demonstrative geometry. Most of the schools herein described are found somewhere between these two practices. The purposes in these various forms are identical, namely, to give the pupil the usable values much earlier, and to increase greatly the probability that he can later pursue a course in plane geometry with interest and profit.

XIV. *Content in Grades Seven, Eight and Nine.* There is agreement that the work of grades seven, eight and nine should include arithmetic, intuitive geometry, algebra and numerical trigonometry. Although some schools advocate the addition also of a unit of demonstrative geometry to the ninth school year, this issue is still debatable. In the Horace Mann School for Girls will be found a provision for a half year unit of demonstrative geometry. The teachers in that school argue that the junior high school years must give all an opportunity to know what is meant by a *proof.* The Ethical Culture School gives a more extensive unit of plane geometry in the ninth year. In the work of the University High School of Chicago, there is an attempt to have a gradual transition from the intuitive to the demonstrative. At no time, however, does the student study plane demonstrative geometry as such.

We see from the foregoing that the tendency is to make the work of these three grades more inclusive. Still further evidence is found in the tendency to introduce earlier than is now customary certain topics and processes which are more closely related to modern needs, such as the use of logarithms and other simple tables, the use of the slide rule, simple work in arithmetic and geometric progressions, the elementary ideas concerning statistics, the technique of graphic representation as a tool in problem solving, and the like. While these topics and others were listed in a preliminary report of the National Committee (Secondary School Circular No. 5) as optional, their appearance in so important a report dealing with the work of the ninth and tenth school years shows the tendency of the times. More material concerning these topics may be found in Part III of this report in the sections dealing with the Stuyvesant High School, The Lincoln School, the High School of Commerce, the English High School (Boston), and others.

XV. *The Bearing of College Entrance Requirements on the Early Years of the High School.* The mistaken notion that it is necessary to formalize the teaching of mathematics throughout the years of the high school in order to make a satisfactory showing on college entrance examinations needs to be overthrown.

There is sufficient evidence in the reports that follow in Part III to show conclusively that it is possible to give worth while courses in the early years of the high school with little reference to college entrance examinations. The reader will learn that the graduates of the English High School (Boston) do creditable work at the Massachusetts Institute of Technology. The graduates of the University High School of Chicago leave little to be desired in their subsequent record in mathematics. The Lincoln School (New York) devotes but three hours per week to mathematics in grades seven, eight and nine; five in grades ten and eleven; and one hour per week (review work) in the twelfth grade. No special lessons have ever been given, nor has tutoring been permitted. The graduates of this school not only are able to pass college entrance examinations, but are given advance credit at colleges of the first rank. The Cass Technical High School (Detroit) has an excellent record at the University of Michigan, to which it sends many of its pupils to take later courses in mathematics.

It is possible that the indictment that college entrance examinations are not the stimulus toward valuable work in mathematics, which they might well be, can be substantiated. But bad as they may be, they are not the obstacles to worth while courses in mathematics that they are frequently believed to be.